

WHAT IS CLAIMED IS:

1. A system for estimating data transmitted by a plurality of transmit elements across a communications channel, comprising:
 - 5 a) a plurality of receive interfaces, each receive interface operative to receive a signal via the communications channel and output a respective sequence of received data elements;
 - b) a space matched filter connected to said plurality of receive interfaces and operative to:
 - 10 i) assemble the received data elements into sets of received data elements, each said set of received data elements including at least one received data element from each sequence of received data elements; and
 - ii) jointly process each set of received data elements with each of a plurality of channel data elements to produce a corresponding plurality of filtered data
15 elements, each filtered data element being associated with one of the transmit elements, each channel data element being representative of a portion of the communications channel between an associated one of the transmit elements and said plurality of receive interfaces;
 - c) a detector connected to said space matched filter and operative to process each
20 filtered data element to produce a corresponding decision data set therefor.
2. The system defined in claim 1, wherein each receive interface comprises a respective receive antenna.

3. The system defined in claim 1, wherein said space matched filter being operative to jointly process each set of received data elements with each of a plurality of channel data elements to produce a corresponding plurality of filtered data elements includes said space matched filter being operative to perform a linear combination of the received data elements in the set of received data elements to produce each of the filtered data elements.

4. The system defined in claim 3, wherein the number of filtered data elements produced from each set of received data elements equals the number of transmit elements.

5. The system defined in claim 1, wherein the decision data set for a particular filtered data element includes a hard decision data set for the particular filtered data element.

6. The system defined in claim 1, wherein the decision data set for a particular filtered data element includes a soft decision data set for the particular filtered data element.

7. The system defined in claim 6, wherein the soft decision data set for the particular filtered data element includes a set of values, each value in the set of values being indicative of a likelihood or reliability associated with transmission of a corresponding symbol by the transmit element associated with the particular filtered data element.

8. The system defined in claim 7, wherein the likelihood or reliability associated with transmission of the corresponding symbol by the transmit element associated with the particular filtered data element includes an *a posteriori* probability.

9. The system defined in claim 8, wherein the *a posteriori* probability is computed at least partly on the basis of:

- i) the particular data element;
- ii) the corresponding symbol; and

5 iii) a plurality of correlation data elements, each correlation data element being representative of a relationship between the channel data element associated with the transmit element associated with the particular filtered data element and a corresponding one of the channel data elements associated with a different one of the transmit elements.

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10. The system defined in claim 1, further comprising a multiplexer for combining multiple decision data sets for filtered data elements associated with different ones of the transmit elements into a single sequence of decision data sets.

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11. The system defined in claim 10, further comprising a de-mapper connected to said multiplexer, said de-mapper being operative to produce a soft representation for each decision data set in the sequence of decision data sets.

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12. The system defined in claim 11, wherein said de-mapper being operative to produce a soft representation for each decision data set in the sequence of decision data sets includes said de-mapper being operative to assign, to a particular data set, a numerical value corresponding to a sum of symbol values weighted by the contents of the particular data set.

13. The system defined in claim 12, wherein the symbol values correspond to numerical representations of respective points in a constellation.

14. The system defined in claim 11, further comprising a decoder connected to said de-
5 mapper, said decoder being operative to transform the soft representations provided by said de-mapper into a stream information symbols.

15. The system defined in claim 14, wherein said decoder is an error correction decoder.

10 16. The system defined in claim 14, wherein said decoder is selected from the group consisting of a turbo decoder, a Reed-Solomon decoder, a convolutional decoder and a block decoder.

17. The system defined in claim 14, said decoder being further operative to generate
15 reliability values on the information symbols, wherein said de-mapper being operative to produce a soft representation for each decision data set in the sequence of decision data sets includes said de-mapper being operative to produce said soft representation at least partly on the basis of the reliability values from said decoder.

20 18. The system defined in claim 10, further comprising a decoder connected to said multiplexer, said decoder being operative to produce a set of information symbols for each decision data set in the sequence of decision data sets.

19. The system defined in claim 18, wherein said decoder being operative to produce a set
25 of information symbols for each decision data set in the sequence of decision data sets

includes said decoder being operative to select one of a predetermined set of information symbols on the basis of the contents of the particular data set.

20. The system defined in claim 19, wherein each set of information symbols in the
5 predetermined set of information symbols corresponds to a respective point in a constellation.

21. The system defined in claim 1, wherein said space matched filter is further operative to
10 obtain the channel data elements from an external source.

22. The system defined in claim 1, wherein said space matched filter is further operative to
compute the channel data elements based on measurements of the communications
channel.

15 23. The system of claim 18, said decoder being further operative to compute statistical
properties of the transmitted data, wherein said detector being operative to process each
filtered data element to produce a corresponding decision data set therefor includes said
detector being operative to (i) compute statistical properties of the communications
channel on the basis of the statistical properties of the transmitted symbols received
20 from said decoder and (ii) process each filtered data element on the basis of the
statistical properties of the communications channel.

24. The system of claim 17, further comprising an interference reducing filter disposed
between said space matched filter and said detector.

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25. The system of claim 24, wherein the interference reducing filter comprises a minimum mean square error (MMSE) filter.

26. A method for estimating data transmitted by a plurality of transmit elements across a communications channel, comprising:

- a) receiving a plurality of signals at a plurality of receive interfaces and outputting a respective plurality of sequences of received data elements;
- b) assembling the received data elements into sets of received data elements, each set of received data elements including at least one received data element from each sequence of received data elements;
- c) jointly processing each set of received data elements with each of a plurality of channel data elements to produce a corresponding plurality of filtered data elements, each filtered data element being associated with one of the transmit elements, each channel data element being representative of a portion of the communications channel between an associated one of the transmit elements and the receive interfaces;
- d) producing a decision data set for each filtered data element.

27. A system for estimating data transmitted by a plurality of transmit elements across a communications channel, comprising:

- a) means for receiving a plurality of signals at a plurality of receive interfaces and outputting a respective plurality of sequences of received data elements;
- b) means for assembling the received data elements into sets of received data elements, each set of received data elements including at least one received data element from each sequence of received data elements;

- c) means for jointly processing each set of received data elements with each of a plurality of channel data elements to produce a corresponding plurality of filtered data elements, each filtered data element being associated with one of the transmit elements, each channel data element being representative of a portion of the communications channel between an associated one of the transmit elements and the receive interfaces;
- d) means for processing each filtered data element to produce a corresponding decision data set therefor.

10 28. A computer-readable storage medium containing a program element for execution by a computing device to implement a space matched filter comprising:

- a) a control entity; and
- b) an I/O entity for receiving an array of data elements including at least one data element associated with each of a plurality of receive interfaces in communication with a plurality of transmit elements across a communications channel,
- 15 c) said control entity being operative to jointly process each array of received data elements with each of a plurality of channel data elements to produce a corresponding plurality of filtered data elements, each filtered data element being associated with one of the transmit elements, each channel data element being representative of a portion of the communications channel between an associated
- 20 one of the transmit elements and said plurality of receive interfaces.

29. A system for data communication over a multi-input, multi-output (MIMO) channel, comprising:

- 25 a) a transmitter unit, comprising:

- i) a de-multiplexer for separating an information stream into a plurality of information sub-streams;
- ii) a plurality of transmit interfaces for simultaneously transmitting respective ones of the information sub-streams over the MIMO channel;

5 b) a receiver unit, comprising:

- i) a plurality of receive interfaces for receiving respective received signals via the MIMO channel and transforming the received signals into streams of received data elements;
- 10 ii) a space matched filter connected to the receive interfaces, said space matched filter adapted to jointly process a vector formed from received data elements from each stream of received data elements together with each of a plurality of channel data elements, each channel data element being representative of a portion of the MIMO channel between an associated one of said transmit interfaces and said plurality of receive interfaces;
- 15 iii) a detector connected to said space matched filter and operative to process each filtered data element to produce a corresponding decision data set therefor; and
- iv) a multiplexer for combining multiple decision data sets for filtered data elements associated with different ones of said transmit interfaces into a single sequence of decision data sets.

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30. The system defined in claim 30, wherein the number of receive interfaces is at least as great as the number of transmit interfaces.

31. The system defined in claim 31, wherein the number of receive interfaces is less than
25 the number of transmit interfaces.

32. The system defined in claim 31, wherein each transmit interface includes a transmit antenna.

5 33. The system defined in claim 31, wherein the MIMO channel is a wireless channel.

34. A system for estimating data transmitted from each of a plurality of users across a communications channel, the data transmitted from the k^{th} user being transmitted via n_k respective transmit elements, comprising:

- 10 a) a plurality of receive interfaces, each receive interface operative to receive a signal via the communications channel and output a respective sequence of received data elements;
- b) a space matched filter connected to said plurality of receive interfaces and operative to:
- 15 i) assemble the received data elements into sets of received data elements, each said set of received data elements including at least one received data element from each sequence of received data elements; and
- ii) for each of the plurality of users, jointly process each set of received data elements with each of a plurality of channel data elements to produce a
- 20 corresponding plurality of filtered data elements for said user, each filtered data element being associated with one of the transmit elements for said user, each channel data element being representative of a portion of the communications channel between an associated one of the transmit elements for said user and said plurality of receive interfaces;

c) a detector connected to said space matched filter and operative to process, for each user, each filtered data element for said user to produce a corresponding decision data set therefor.

5 35. The system defined in claim 34, wherein the number of transmit elements for each user is greater than one.

36. The system defined in claim 34, residing in a base station.